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ABSTRACT

The paper focuses on networking, a process of identifying and understanding the relationships among concepts in prose passage, as a learning strategy for deaf college students. It is explained that students using the technique perform three basic overlapping processes, one of which, identification and understanding of concept relationships, is the subject of a literature review. Reported are findings of evaluations conducted during three networking training sessions involving 56 students from the National Technical Institute for the Deaf (NTID). During each session, NTID students were trained on the networking procedure and then asked to study prose passages and use their new study strategy. Findings using the relatively short (500 word) passages in sessions I and II suggested that networking has a greater impact on long term retention of prose than on immediate test performance and that networking has more of an impact when students write out their networks than when they network material in their head. There were mixed results regarding the performance on the longer (1,000 word) articles of session III. Appended is information on definition, example characteristics, result, and compare/contrast relationships. (SB)

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Networking: A semantic-based learning strategy for improving prose comprehension

Paper Series No. 26

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1978

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NTID's principal goal in doing research is to influence the education, training and career placement of deaf citizens through systematic examination of issues related to deafness. As one part of NTID's total research effort, the Department of Research and Development conducts descriptive and experimental research. Research findings are used in the development of programs and materials in the areas of learning and instruction, personal and social growth, and career development of deaf students. This document was developed in the course of an agreement with the U.S. Department of Health, Education and Welfare.

ABSTRACT[1]

Networking, a learning strategy which emphasizes the process of identifying and understanding the relationships among concepts in a prose passage, was developed. In addition, a set of training procedures were created to communicate the networking system to deaf college students. The networking strategy was assessed in the context of a 5-hour pilot training program and two extended, 10-week (2 hours per week) learning skills courses. Although the results of the present study are mixed, networking was found to have potential as an effective prose learning strategy.

[1]An earlier version of this paper was presented at the annual meeting of the American Educational Research Association, Toronto, Ontario, Canada, 1978.

INTRODUCTION

In an extensive review of the educational and psychological literature, Dansereau, Actkinson, Long and McDonald (Note 1) concluded that much of the past educational research and development effort has been directed at the improvement of teaching rather than the learner aspects of education. These teaching aspects included modulation of material, manipulation of frequency of reinforcement, pacing, mode of presentation, etc, whereas the learner aspects included deciding on the importance of concepts, reorganization and re-representation of material, and understanding the relationships between concepts. The present study focused on the development of networking, a strategy for learners that can be used to actively dissect and thus better understand prose materials. The networking technique evolved from two domains. First, it was drawn from the cognition and education literature which suggests that: (a) material is stored in a node-like fashion with nodes representing concepts or ideas and the links between the nodes representing the relationships between the concepts or idea unit (Collins & Quillian, 1969; Lindsay & Norman, 1972; and Meyer & Schvaneveldt, 1976), and (b) semantic organization of prose material is related to later recall of that material (Crothers, 1970; Dahl, 1973; Kintsch, 1974; Meyer, 1971). Second, the networking technique was based on our pilot experiences of identifying important relationships commonly found in prose, training students to understand and use these relationships and then, revising the program based on student response and adequacy of the relationships.

The networking technique which evolved presents students with a system for dissecting and re-representing the basic relationships of prose materials, wherein text material is converted into a two-dimensional node link diagram.

The networking technique is designed to enhance learning from prose material by facilitating the following processes: (a) selection of the important material for further processing, (b) identification and understanding important relationships between portions of this material, and (c) cognitive reorganization and re-representation of the material.

The three hypothesized processes are not seen as discrete steps but as overlapping events that flow into one another.

(Insert Figure 1 about here)

For example, a student selecting material from a passage is probably using information about the relationships between concepts as a guide for determining what material is regarded as being important (i.e., "this term is important because it is related to many other terms in the passage.") Selecting the important material, identifying the relationships between terms, and re-representing the material in a network should lead to an effective reorganization of the material.

We are not saying that selection, cognitive reorganization and understanding concept relationships are the sole determiners of comprehension. Rather we are suggesting that these three processes are important for dissecting and understanding written materials and that by enhancing these processes one can enhance comprehension. Other factors, such as student vocabulary knowledge, and world knowledge impact considerably on

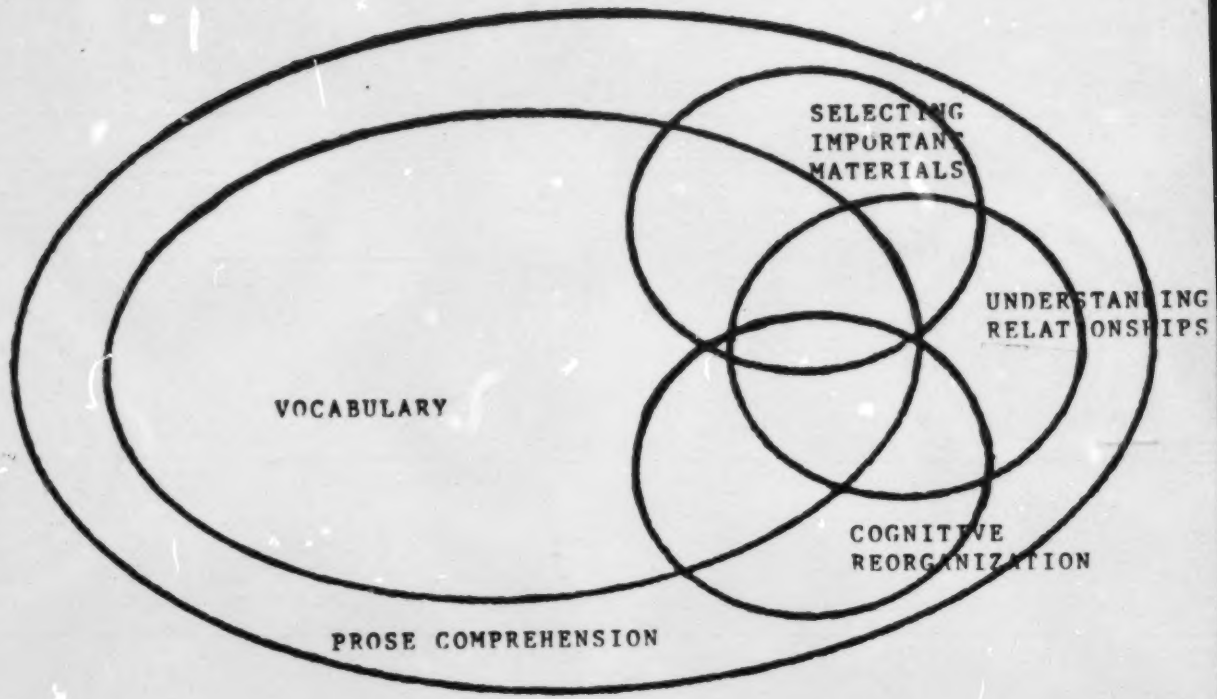

Figure 1: Prose comprehension from a networking perspective.

the comprehension; of a particular passage. However, the present research and development effort focuses primarily on prose learning processes and strategies. Prose learning processes will be discussed in the literature review section: however, prior to that it is necessary to briefly outline the networking technique.

THE NETWORKING TECHNIQUE

Networking is a learning strategy. Students using the technique perform three basic overlapping processes as noted in Figure 1: a) identifying and understanding relationships, b) selection of important material from text, and c) cognitive reorganization. Students are taught to look for six basic relationships in their reading: 1) example, 2) characteristic, 3) definition, 4) sequence, 5) result and 6) compare/contrast. These relationships are defined in Appendix A.

Using these relationships, students create a two dimensional diagram of the text material.

(Insert Figure 2 about here)

It is hypothesized that this two dimensional diagram is a reflection of the student's cognitive reorganization of the text material.

Without going into the relationships specified in the 'Antique Cars Network' of Figure 2, notice that: a) the main terms or ideas (nodes) have been selected from the passage, b) the relationships between these terms have been expressed by the links (i.e., lines between terms), and c) that the network is a re-representation of the material in a form which differs in organization from the original linear presentation.

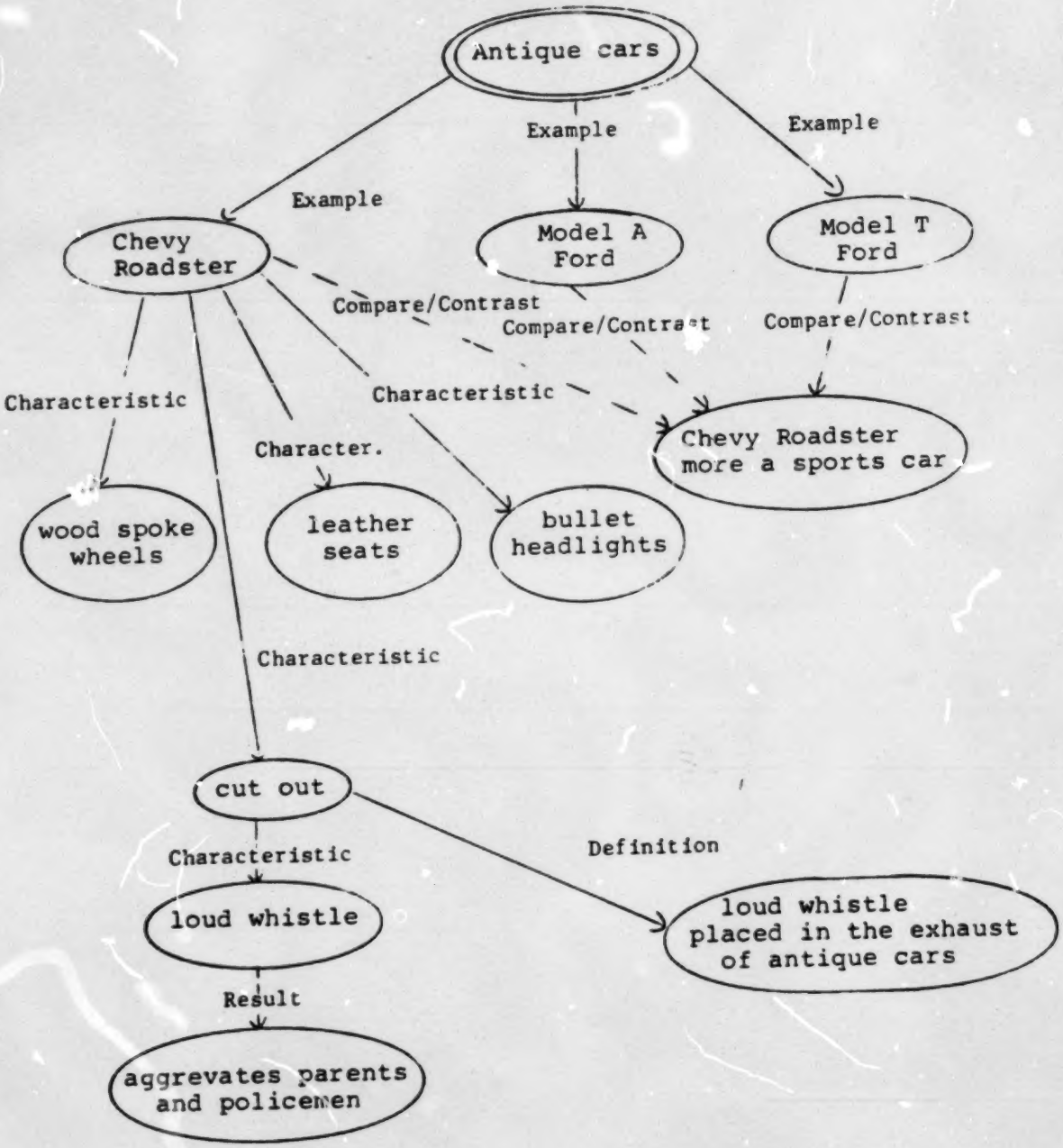

Figure 2: An example of a network. (Text: The Chevy Roadster, Model A Ford, and Model T Ford are different kinds of antique cars. The Chevy Roadster is more of a sports car than the Model A and Model T Fords. The chevy Roadster has wood spoke wheels, leather seats, bullet headlights and a cutout. A cutout is a loud whistle placed in the exhaust pipe of antique cars which can be turned off and on from the dash. Turning on the cutoff results in a loud whistle which aggravates parents and policemen.)

The networking technique employed in the present study is seen as a language system for describing previously implicit processes and semantic structures. Thus, at least a portion of prose learning can be transformed from an abstract, covert procedure to a systematic set of verbalizable processes.

A REVIEW OF THE LITERATURE

This review of the literature will focus on one of the three major processes of networking (identification and understanding concept relationships). For additional material on this and the other two processes, refer to Long (1976) and Long and Conklin (Note 3).

IDENTIFICATION AND UNDERSTANDING OF CONCEPT RELATIONSHIPS

One of the processes incorporated into networking is the identification and labeling of important links (relationships) between portions of prose material. The identification of semantic relationships has been researched by individuals concerned with the representation of conceptual material in memory (i.e., Collins & Quillian, 1969; Lindsay & Norman, 1972; and Meyer & Schvaneveldt, 1976), and individuals concerned with generating semantic representations of prose passages (Crothers, 1970; Dahl, 1973; and Kintsch, 1974). To varying degrees, research in each of the above domains has influenced the conceptualization of the networking technique. However, it is important to note that their focus has been on models of memory and semantic representation of text material,

whereas the present study focused on the question, "Can prose comprehension be facilitated by training a semantic learning strategy?"

Collins and Quillian (1969), and Meyer and Schvanveldt (1976) have hypothesized that human memory includes a semantic network that represents various categories of objects (i.e., nodes at functionally distinct memory locations). The relationships between these nodes are indicated by named links such as, superset and property of. Figure 3 provides an example of an inferred semantic memory network for storing information about familiar categories of objects adapted from Collins and Quillian (1969).

(Insert Figure 3 about here)

Their interpretation is that concepts, like table, chair and furniture, or robin, canary, and bird are at functionally distinct locations of a semantic network. Between these nodes, the inferred network has various types of labeled links that specify relationships.

Collins and Quillian (1969) tested the feasibility of their node-link model as a representation of memory storage by observing how quickly students could answer true or false to a series of questions related to the structure in Figure 3.

For example:

Does a canary sing?

Does a canary have feathers?

Does a canary breathe?

Their results indicated that the more nodes that needed to be checked (or links crossed), the longer it took subjects to provide an answer. Thus the questions "Does a canary sing," and "Does a canary

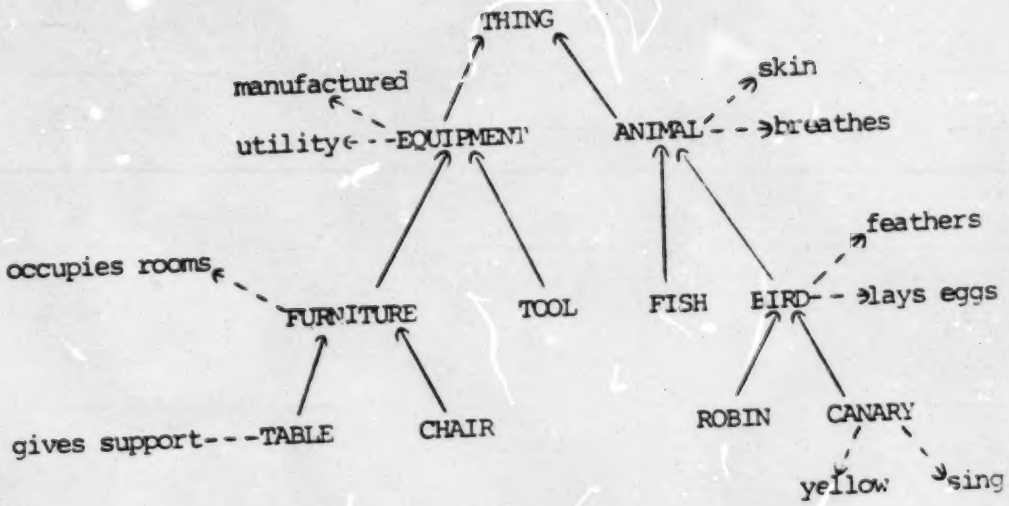

Figure 3: Part of an inferred semantic memory network adapted from Collins and Quillian (1969). A solid line denotes a 'superset' relationship, and a dashed line denotes a 'property' relationship.

breathe" took 1.3 and 1.5 seconds respectively. The extra .2 second is seen as resulting from memory search needed to bring together information located in nodes at different parts of the structure.

In summary, the research of Collins and Quillian (1969) provides some evidence for the hypothesis that semantic information is stored in memory in a node-link fashion. A similar type of node link representation is used in the networking technique taught to students in the present study. It was felt that such a representation would be compatible with memory structures (if Collins and Quillian's model is correct) and its explicit specification would consequently facilitate retrieval of stored material. That is, after storing material in a node-link fashion, could students use the links between terms as cues to aid retrieval (e.g., What are some characteristics of canaries?)?

The identification of semantic relationships has also been researched by Crothers (1970), Dahl (1973), and Kintsch (1974). They were interested in the development of procedures for analyzing the underlying structure of prose material. Crothers (1970) developed a two step procedure for analyzing prose materials that was later refined and tested by Dahl and by Kintsch. Crother's system results in an annotated "tree diagram" showing the semantic relationships in a text. First, the passage is broken up into "basic sentences" and then a "semantic hierarchy" of these sentences is established. Crothers never does say what constitutes a "basic sentence," rather he provides examples such as the following:

Example: "Tom went to town and bought a hat." is broken down into:

(a) Tom went to town.

(b) Tom bought a hat.

Crothers allows considerable leeway about what constitutes a basic sentence (e.g., Tom went) which allows the subjective judgment of the diagrammer to enter into the decision process.

The second step is the establishment of a "semantic hierarchy of the basic sentences." The method Crothers suggests for doing this is to subordinate one sentence to another if a referent of the first sentence is an example or a referent of the second.

His example: "The writing instrument was lost" is superordinate to, "The pen was lost." In general, more subordinate items elaborate on more superordinate items (i.e., give characteristics of the superordinate items, etc.).

Kintsch, Kozminsky, Streby, McKoon, and Keenan (1975) diagrammed prose passages using Crother's method, had students read the intact passages, and subsequently tested students' recall of the material. Their results indicated that superordinate propositions (e.g., the Babylonians built a garden) were recalled better than subordinate propositions (e.g., Babylonians planted flowers) and forgotten less when recall was delayed. Thus, the semantic diagram technique proposed by Crothers and studied by Kintsch has been shown to dissect prose in a fashion that can be related to memory for text.

In the research projects by Collins, et al, and Kintsch, et al, the exact nature of the semantic relationships has not been clearly delineated. This is at least partially due to the focus of these projects. The present project, which focuses on training students to understand and use semantic relationships, defined each "important" relationship, and

developed training materials to help students identify and understand these relationships. As was noted, networking consists of six basic relationships (example, characteristic, definition, sequence, result, and compare/contrast). These six types of relationships are not seen as an exhaustive list. Rather, they were selected for training based on pilot study data which indicated that the links: (a) generalized across a variety of materials, and (b) were trainable to deaf college students at NTID.

Since the semantic structure of prose material is related to comprehension and retention of that material, training students to dissect and re-represent the semantic structure of prose should lead to increased comprehension and retention. However, no previous research has been done on teaching students to network the relationships between portions of prose material.

In summary, there is evidence to suggest that: (a) material is stored in node-link fashion which reflects relations between concepts, and (b) location of text segments in a hierarchical diagram of prose material is related to later recall of that material. Thus it follows that training students to specify the relationships between portions of prose material may lead to increased comprehension and retention of that material.

OVERVIEW

The following section reports the findings of evaluations conducted during three networking training sessions administered during the 1977-78 academic year. During each session a group of NTID students were trained on the networking procedure and then asked to study prose passages and use their new study strategy. Students then took either an immediate or delayed test given to assess their comprehension and retention of the passage. Table 1 presents detailed information on the number of subjects, training procedures, test passages and type of test used in each training session.

(Insert Table 1 about here)

It is important to note that the networking training materials went through some revisions following each training session. The materials evolved from handouts with instructions on networking and practice sentences to a 200 page programmed text focusing on 6 specific relationships. Although the quantity and (we hope) the quality of the training materials improved from session to session, all materials focused on training students to recognize and understand important relationships in text material.

The groups trained on networking were relatively small due to the volunteer nature of the program. The Plains Indians and Great Apes passages and tests used in sessions I and II respectively, were repeated in session III. Repetition of evaluation materials allowed the experimenters to combine some of the data from sessions I, II and III resulting in larger groups for the final analyses.

TABLE 1 - INFORMATION ON THE THREE LEARNING STRATEGY TRAINING SESSIONS

TRAINING SESSION	DATE	SUBJECTS	TRAINING PROCEDURE	TEST PASSAGES	TYPE OF TEST
I	Summer, 1977	Experimental (N=6) Control (N=17)	Time: 5-hour pilot training program. Materials: Handouts with instructions on networking sentences along with practice sentences.	BIOFEEDBACK (Approximately 500-word article from a psychology text). PLAINS INDIANS (1000 word article from Scientific American).	Immediate and delayed test on BIOFEEDBACK article. Delayed test on PLAINS INDIANS passage.
II	Fall, 1977-78	Experimental (N=9) Control (N=12)	Time: 10-week (2 hours per week) course. Materials: Partially completed programmed text with instructions on "5 important relationships" and practice exercises using sentences, paragraphs and short passages.	GREAT APES (Approximately 1000 word article from Scientific American). SHIFTY BUGS (Approximately 500 word article from Time). RAIN FOREST (Approximately 500 word article from Scientific American).	All tests were given one week after the students read the passages. Both cued and uncued questions were included for the GREAT APES passage. Questions over SHIFTY BUGS and RAIN FOREST passage, were a variety of different types.

TABLE 1 (continued).

III	Spring, 1978	Experimental (N=12) No control group	Time: 10-week (2 hours per week) course. Materials: Programmed text (about 200 pages) containing instructions and exercises on; characteristic, example, definition, sequence, result and compare/contrast relationships.	GREAT APES - same passage as in Session II. PLAINS INDIANS - same passage as in Session I.	All tests were given one week after the student read the materials. GREAT APES - same test as Session II. PLAINS INDIANS - same test as Session I.

Training Session I

The purpose of training session I was to pilot the networking procedure on a small group of deaf students and determine if a short exposure to the networking strategy would result in better comprehension and retention of academic like materials than that accomplished by a no treatment control group. Both immediate and delayed testing occurred.

Method

Subjects

Twenty-three deaf students (13 males and 10 females) from the National Technical Institute for the Deaf participated in this study. All students were volunteers who were taking part in a summer orientation program prior to their freshman year in college. Six students received 5 hours of networking training over a three week period. The remaining 17 control subjects participated in two-one hour testing sessions.

Procedure

In general, students were trained on the networking technique in the following manner.

1. Experimenter lead a brief discussion on "Why are learning strategies important for you" and gave a brief overview and description of the technique.
2. Students read background information on networking and information about the first three relationships (characteristic, definition and example).

3. Students network simple sentences using the characteristic, definition and example relationships and receive written experimenter feedback.
4. Students read background information on result and compare/contrast relationships.
5. Students network simple sentences using the result and compare/contrast relationships and receive written experimenter feedback.
6. Students network complex sentences with a variety of relationships and receive experimenter feedback.
7. Students apply networking to prose passages (i.e., a 1,000 word Scientific American article segment on Plains Indians and a 500 word passage from a psychology text on Biofeedback) without experimenter feedback.
8. Students receive an immediate test over the psychology text.
9. Delay period of approximately 1 week.
10. Both groups of students (experimental and control) return and review their notes or networks for 5 minutes.
11. Students receive a delayed test over the Scientific American article and are retested over the psychology text.

The control group read the prose passages and filled out the immediate and delayed tests. The control group was told that they would be tested over the study material and that they should study for the test the way they "normally" study. The subjects in this group did not receive any strategy training. Both groups were given equal amounts of study and test taking time.

Results and Discussion

Separate t tests were performed to compare treatment and control group performance on an immediate and delayed test over the Biofeedback passage. The data from the delayed test over the Plains Indians passage were combined with data from session III and will be reported in a later section. Table 2 gives the mean number of correct responses for the control and networking groups for each Biofeedback test condition. Group comparisons indicated that performance of the networking and control groups did not differ significantly on the immediate Biofeedback test, $t(21) = 1.35$, $p > .05$ nor on the delayed Biofeedback test, $t(21) = 1.52$, $p > .05$. It should be noted however that the experimental group outperformed the control group by 55% on the immediate test and 62% on the delayed test.

(Insert Table 2 about here)

In attempting to understand why the networking program did not have a significant effect on performance on Biofeedback passage questions, two possible reasons shall be considered. First, from a statistical perspective, the within cell variances were rather large and the sample of subjects relatively small with only six students in the treatment group. The second consideration was that the control group may actually have received a "treatment" in the sense that the immediate test served as an active review of the text material. A number of studies have shown that providing questions following text material improves recall of information that is related to those questions (Frase, 1970; Frase & Schwartz, 1975). It is possible that the test taken ten minutes after reading the text material caused them to reorganize the material they

Table 2

Mean Scores for Experimental and Control Subjects
on Immediate and Delayed Questions
over the Biofeedback Passage
(Session I, Summer 77)

PASSAGE AND TEST	EXPERIMENTAL (n=6)	CONTROL (n=17)	t
Biofeedback Immediate Test			
M	48.33	31.18	1.35
S.D.	31.88	24.78	
Biofeedback Delayed Test			
M	52.50	32.35	1.52
S.D.	27.16	27.96	

had just stored. Thus, the immediate test questions could have served as an adjunct aid for the control groups bringing about a relatively intense processing of the material previously studied.

The second session avoided the effect of immediate testing since both the treatment and control groups received only the delayed test.

Training Session II

The purpose of Session II was to determine if training deaf students on the networking strategy would result in better comprehension and retention of academic like materials than that accomplished by a no-treatment control group. Session II had the following advantages when compared to Session I:

1) Students received more extensive training in networking.
2) All tests were delayed.
3) There was a more controlled evaluation of treatment effectiveness since groups were compared to assure equality on vocabulary level.

Method

Subjects

Twenty-one deaf students (15 males and 6 females) from the National Technical Institute for the Deaf participated in the study. The nine students in the networking group received approximately 20 hours of training over a ten week period as part of a learning strategies course. The twelve students in the control group were volunteers from an introductory psychology course and received experimental credit for their participation.

Procedure

The sequence of events for the nine students receiving networking training was similar to that outlined in Session I. However, students were given more practice in networking simple and complex sentences along with additional exercises on networking paragraphs, passages and test questions. The training materials used in this session can be found in a technical report by Long and Conklin (note 3). The control group read the prose passages in a 1 1/2 hour session and returned one week later to take the delayed tests and a vocabulary test.

The Delta Vocabulary Test (Diegnan, note 4) was administered to both the experimental and control groups. The Delta Vocabulary Test is a ten minute, 45 item, multiple choice test which correlates highly with much longer, more inclusive measures of verbal ability. It also has been found to be directly related to comprehension and long term retention of prose materials Dansereau (note 5) and Long (1976). More specifically, in a series of studies the Delta had significant correlations with test questions over eleven separate training passages (range .45 to .94) for both deaf and hearing trainees. Consequently the Delta Vocabulary test was administered to students in this study to assess group equality. The control group (M=15.27) scored slightly higher on the vocabulary measure than the experimenal group (M=14.88), but a test of group differences was not significant. Although subjects were not randomly assigned to treatments in the present experiment, the two groups had relatively the same vocabulary level.

Subjects read and were tested over three passages (Great Apes, approximately 1,000 words) and (Rain Forest, approximately 500 words) taken from Scientific American articles. The third passage (Shifty Bugs, approximately 500 words) was about sleeping sickness and was abstracted from the medicine section of Time.

An additional condition was introduced into Experiment II by asking the experimental group to network the Rain Forest passage in their "head" rather than on paper. Thus both groups studied the Rain Forest passage without underlining or taking any notes. The data from questions over the Great Apes passage was combined with test results from session III and will be reported in a later section.

Results and Discussion

Separate t tests were performed to compare treatment and control group performance on tests over the Shifty Bugs and Rain Forest passages. Table 3 gives the mean number of correct responses for the control and networking groups for each test condition. Group comparisons indicated that the networking group significantly outperformed the control group on questions over the Shifty Bugs passage, $t(19)=2.34$, $p < .05$. However, performance of the two groups did not differ significantly on questions over the Rain Forest passage.

(Insert Table 3 about here)

Table 3

Mean Scores for Experimental and Control Subjects
on Shifty Bugs and Rain Forest Questions
(SESSION II, FALL 77)[a]

PASSAGE	EXPERIMENTAL (n=9)	CONTROL (n=12)	t
SHIFTY BUGS			
M	7.20	4.00	2.34*
S.D.	3.29	3.10	
RAIN FOREST[b]			
M	6.67	5.75	<1
S.D.	3.74	3.22	

[a] all tests were delayed

[b] experimental group networked in their head rather than on paper

* p <.05

When studying the Rain Forest passage, the experimental group was instructed to do their networking in their "heads" rather than on paper as they did for the Shifty Bugs passage. Results of the analyses indicated that the experimental group outperformed the control group on questions over the Shifty Bugs article but did not outperform the control group on the Rain Forest article. Thus there is some indication that networking has more of an impact when students actively write out the networks than when they network material in their head. It is possible that the facilitative effect of networking comes about when students are selecting and reorganizing concepts to include in their networks. However, it is also possible that the facilitative effect comes from reviewing the network rather than generating it. These findings are consistant with Carter and Van Matre (1975) who found the facilitative effect of class notes to be more from reviewing the notes than from taking them. Further research is needed to clarify the kind of impact networking is having on the comprehension/retention process.

Training Session III

The purpose of session III was to expand the data base and allow for an adequate evaluation of treatment effectiveness. The Plain Indians and Great Apes passages and tests used in sessions I and II respectively were repeated in session III. Training session III improved on the previous sessions by:

1) including "sequence" as a new relationship in the training materials.
2) expanding the number of exercises in the student's manual.

3) combining data from sessions I and III resulted in 16 experimental and 16 control subjects for the Plains Indians passage.

4) combining data from sessions II and III resulted in 20 experimental and 10 control subjects for the Great Apes passage.

5) by combining data from sessions I, II and III, we were able to include student vocabulary level in the experimental design.

Method

Subjects

Twelve deaf students (9 males and 3 females) from National Technical Institute for the Deaf participated in the study. Students received approximately 20 hours of training over a ten week period as part of a learning strategies course. The subjects in the control group were from sessions I and II and were described previously (see Table 1).

Procedure

The training sequence for session III was very similar to the sequence described for the previous sessions. However, the number of exercises in each section of the training manual was expanded and the "sequence" relationship was added (see appendix A). The training material used in this session can be found in a technical report by Long, Hein, Coggiola and Pizzente (note 6).

After receiving networking training, all subjects read and were tested over two 1,000 word passages (Plains Indians and Great Apes) from Scientific American. Approximately one week after reading the passages, students were given 5 minutes to study their networks and then answered questions over each passage. Questions used to measure prose comprehension on the Great Apes passage were divided into two types (cued-uncued)

and were analyzed separately. Cued questions provided students with information regarding possible alternative responses and were usually a verbatim statement from the passage (e.g., In running, a gibbon's arms are used (a) very little, (b) for traction, (c) for balance, (d) as legs). Most multiple choice, true-false, and fill in the blank questions were considered cued questions. Uncued questions gave the student little or no information about the "correct response" and were not taken verbatim from the text (e.g., List all you know about the gibbon).

Results

A two way, 2 x 2 factorial analysis of variance was performed on test scores over each of the prose passages. The factors in the ANOVA were strategy (networking, control) and student vocabulary level (high, low). The vocabulary factor was achieved by splitting the experimental and control groups into two cells (high vocabulary subjects and low vocabulary subjects). T's procedure allowed for an examination of the impact of vocabulary level and possible strategy x vocabulary level interactions. The Delta Vocabulary Test (Diegnan, note 4) used in this study is discussed in the procedure section of training session II.

The mean vocabulary scores and means for cued and uncued questions over the Great Apes passage are presented for each group in Table 4. The results of separate analysis of variance on cued and uncued questions indicates that neither the strategy effect or vocabulary level factor were significant.

(Insert Tables 4, 5 and 6 about here)

Table 4

Mean Vocabulary Scores and Great Apes Test Results for Experimental and Control Groups.

GROUP	VOCABULARY	QUESTIONS OVER GREAT APES PASSAGE	
		UNCUED	CUED
EXPERIMENTAL (HIGH VOCABULARY)			
M	22.70	11.90	9.60
SD	7.69	7.78	3.47
(n=10)			
EXPERIMENTAL (LOW VOCABULARY)			
M	8.60	10.40	8.80
SD	3.31	3.69	2.94
(n=10)			
CONTROL (HIGH VOCABULARY)			
M	22.00	11.60	9.40
SD	8.37	6.31	3.65
(n=5)			
CONTROL (LOW VOCABULARY)			
M	10.20	2.80	7.80
SD	1.48	3.90	2.49
(n=5)			

Table 5

Analysis of Variance for Groups by Vocabulary Level on Great Apes Uncued Questions

SOURCE	df	MS	F	PROBABILITY
GROUP (TREAT X CONTROL)-A	1	104. 02	3.05	.09
VOCABULARY LEVEL-B	1	116.03	3.40	.07
A X B	1	88.82	2.60	.12
ERROR	26	34.13		

Table 6

Analysis of Variance for Groups by Vocabulary Level on Great Apes Cued Questions

SOURCE	df	MS	F
GROUP (TREAT X CONTROL)-A	1	2.40	< 1
VOCABULARY LEVEL-B	1	8.53	< 1
A X B	1	1.07	< 1
ERROR	26	10.15	

Upon examination of the means in Table 4 it is readily apparent that little if any differences exist among the first 3 groups listed (experimental high vocabulary, experimental low vocabulary and control high vocabulary). However, the low vocabulary control subjects have somewhat lower scores than the other three groups. Although these differences are not significant, it is important to note that the low vocabulary subjects in the experimental group have somewhat higher scores (especially on uncued questions M = 10.4) than would be expected given the somewhat lower performance of the low vocabulary subjects in the control group (M = 2.80).

Table 7 presents the mean vocabulary scores and Plains Indians test results for the experimental and control groups.

(Insert Tables 7 and 8 about here)

Analysis of Plains Indians scores indicated that the experimental group outperformed the control group $F(1,28)=7.72$, $p < .01$ and high vocabulary subjects outperformed low vocabulary subjects $F(1,28)=15.21$, $p < .01$. The strategy x vocabulary level interaction was not significant.

Discussion

It was hypthesized that the use of the networking technique would result in significantly better comprehension scores in comparsion to a no treatment control group. The data obtained from training sessions I, II and III only partially support this hypothesis. The results using the relatively short (500 word) passages in sessions I and II suggest that:

Table 7

Mean Vocabulary Scores and Plains Indians Test Results for Experimental and Control Groups.

GROUP	VOCABULARY	PLAINS INDIANS
EXPERIMENTAL (HIGH VOCABULARY)		
M	25.75	46.12
SD	8.12	14.33
(n=8)		
EXPERIMENTAL (LOW VOCABULARY)		
M	9.12	24.50
SD	3.76	13.52
(n=8)		
CONTROL (HIGH VOCABULARY)		
M	18.50	30.62
SD	7.29	23.00
(n=8)		
CONTROL (LOW VOCABULARY)		
M	8.88	9.62
SD	2.17	6.19
(n=8)		

Table 8

Analysis of Variance for Groups by Vocabulary Level on Plains Indians Questions

SOURCE	df	MS	F
GROUP (TREAT X CONTROL)-A	1	1845.28	7.72*
VOCABULARY LEVEL-B	1	3633.78	15.21*
A X B	1	.78	< 1
ERROR	28	238.88	

*p < .01

1. Networking has a greater impact on long term retention of prose (i.e., Shifty Bugs passage) than on immediate test performance (i.e., Biofeedback passage).

2. Networking has more of an impact when students write out their networks (i.e., Shifty Bugs passage) than when they network material in their head (i.e., Rain Forest passage).

Examining the test results of the longer (1,000 word) articles presented in session III we find:

1. Networking did not significantly influence performance on the Great Apes passage. However, the low vocabulary subjects in the networking group scored at about the same level as the high vocabulary subjects. If networking facilitated performance at all, it was only with the low vocabulary subjects.

2. Networking did facilitate performance on the Plains Indians passage. Vocabulary level was also a potent contributor to performance with high vocabulary subjects outperforming the low vocabulary subjects.

The passages and questions used in the three training sessions were not generated so that a match existed between the relationships expressed in the passages, the relationships required to answer the questions, and the set of relationships used in networking. Instead the passages and questions used in the present study were picked because they appeared to be like "typical" college text material and were readily available. This somewhat random selection of material and questions combined with the relatively small samples of subjects made it difficult to draw specific conclusions about the impact of networking on different passages and different types of questions. Further studies on semantic networking of prose should systematically analyze the passage materials and questions. Passages that have similar content but vary in terms of

syntax and/or vocabulary level should be used and included as a factor in the design. Questions should be analyzed in terms of the type of relationship required to answer the question and the reading difficulty level of each question. Systematic manipulation of passage and question dimensions will allow for a more direct assessment of networking.

Although the present study had mixed results, networking shows promise as an effective learning strategy. Further research is needed to delineate the exact impact of networking on the learning process, however the foundation has been layed for a cognitive process based learning strategy training program.

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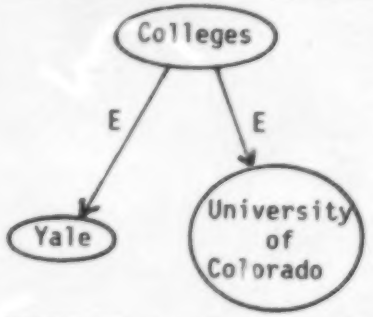
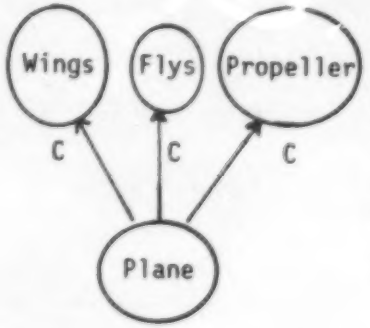
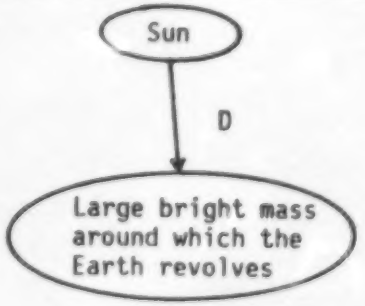
APPENDIX A

Information on definition, example characteristic, result and compare/ contrast relationships.

Table 1.1: Example, Characteristic, and Definition Relationships: Clue Words, Definitions and Sample Networks

Relationship	Definition	Sample Network	Clue Words
Example	Member of a larger group of objects		____ (is a type of) _____ ____ (is a kind of) _____ ____ (is an example of) _____ ____ (Is in the category of ____ (___ procedures for) ___ (are) _ (Two types of) ____ (are) _____
Characteristic	To have or do something		____ (has) _____ ____ (is characterized by) _____ (One feature of) __ (is) _____ (A property of) __ (is) _____ (An aspect of) _____ (is) _____ (An _____ of) _____ (is) _____ ____ (is a characteristic of) ___
Definition	The meaning of a term		____ (Is called) _____. ____ (can be defined as) _____ _____(is) _____ _____ (can be interpreted as) ___ ____ (is explained as) _____ ____ (refers to) _____ ____ (as a procedure for) _____

Exercises on Definition, Example and Characteristic Relationships

The next few pages contain exercises on the definition, example, and characteristic relationships. These exercises are designed to help you understand and apply the ideas from Table 1.1.

Directions: For each sentence fill in two blanks. First, from the choices listed below each sentence, choose the "clue words" which best complete the sentence. Then, from the two relationships listed, choose the correct one. If you are not sure of your answer, look back at Table 1.

1. An orange _____ fruit.

   (is a type of)

   (is a feature of)

   1. This is a(n) _____ relationship

   (example)

   (characteristic)

2. Tobacco rolled in a piece of paper _____ a cigarette.

   (is a type of)

   (is called)

   2. This is a(n) _____ relationship.

   (definition)

   (example)

3. An ankle _____ a joint between the foot and the leg.

   (can be defined as)

   (is a part of)

   3. This is a(n) _____ relationship.

   (definition)

   (example)

4. Dogs _____ faithful.

   (is called)

   (are)

   4. This is a _____ relationship.

   (characteristic)

   (definition)

Listed below are the answers for the previous page, and explanations of why they were chosen. Do you agree with them?

1. "Is a type of"
   An Example relationship
   (NOTE: "Is a feature of" indicates a characteristic relationship. An orange is not a characteristic of fruit.

2. "Is called"
   A Definition relationship.
   (Note: "Is a type of "does not work, as we are not talking about a specific type of cigarette, e.g., Winston.)

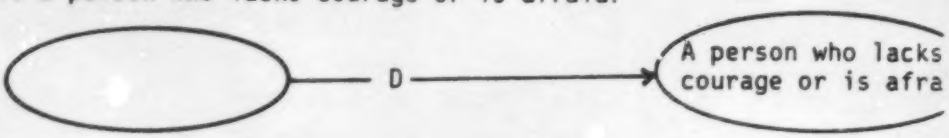
3. "Can be defined as"
   A Definition relationship
   (Note: "Is a part of" does not work, as an ankle is not the name of a part of a joint but rather is a name for whole joint.)

4. "Are"
   A Characteristic relationship.
   (Note: "Is called" does not make sense in the sentence.)

DIRECTIONS: These networks are based on the relationships from Table 1. Please read the sentence above each network and fill in the blank space. Then fill in the blank node in the network. You can look back at Table 1.

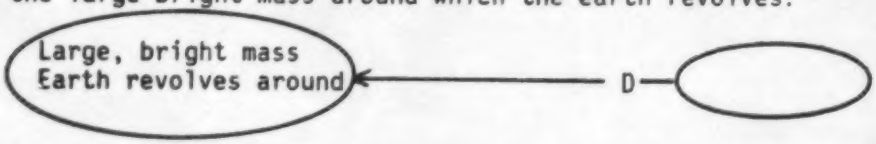
1. A _____ is a person who lacks courage or is afraid.

Definition:



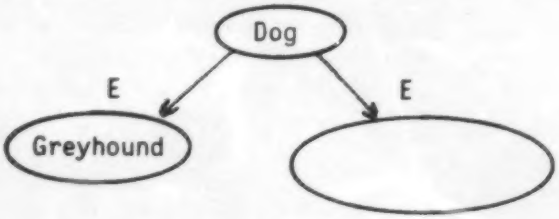
2. The _____ is the large bright mass around which the earth revolves.

Definition:



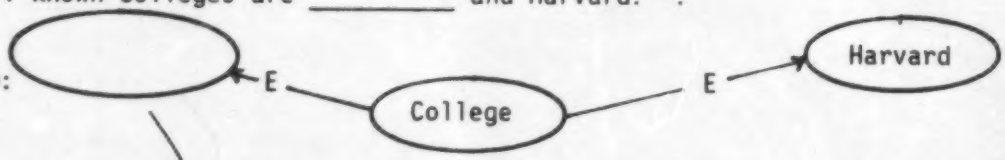
3. Greyounds and _____ are two types of dogs.

Example:

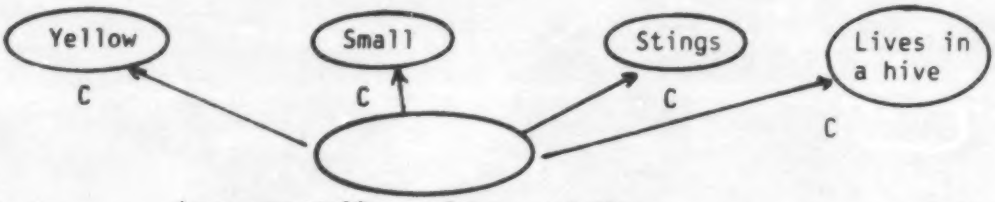


4. Two well known colleges are _____ and Harvard.

Example:



5. A _____ is a small, yellow insect which lives in a hive and stings other animals.



6. An _____ has a propeller, wings, and flys.

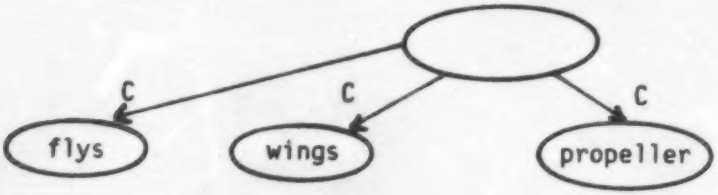
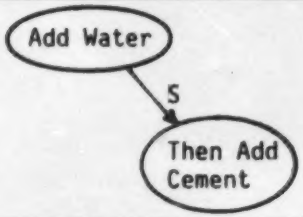
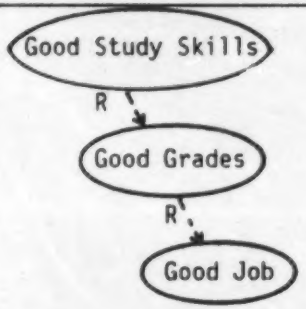
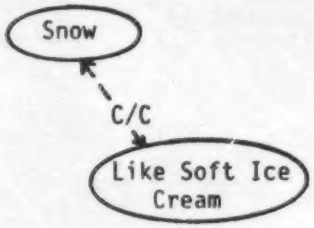


Table 2.1. Sequence, Result and Compare/Contrast Relationships: Definitions, Sample Networks and Clue Words

Relationship	Definition	Sample Network	Clue Words
Sequence	One event or thing occurs after another.		_____ (follows) _____. _____ (then add) _____. _____ (earlier than) _____. (subsequently) _____. (after) _____, _____. (first) _____, (then) _____.
Result	When one thing leads to or influences another		_____ (depends on) _____. _____ (influences) _____. _____ (has an effect on) _____. _____ (acts on) _____. _____ (operates on) _____. _____ (is a function of) _____. _____ (results in) _____. _____ (leads to) _____. _____ (produces) _____. _____ (causes) _____.
Compare/Contrast	How two or more things are similar or different		_____ (can be contrasted to) _____. _____ (is greater than) _____. _____ (is) _____ (to) _____. _____ (is different than) _____. _____ (is like) _____. _____ (is harder) _____. _____ (is easier than) _____. _____ (is) _____ (than) _____.

Directions: For each sentence, fill in two blanks. First, from the choices listed below each sentence, choose the "clue-words" which best complete the sentence. Then from the two relationships listed, choose the correct one. If you are not sure of your answer, look back at Table 2.1.

1. The Fall season _____ the summer months. This is a _____ relationship.
   (follows) / (depends on) — (result) / (sequence)

2. The Model T Ford _____ the old horse. This is a _____ relationship
   (has) / (cost more than) — (characteristic) / (compare/contrast)

3. The cost of living went up _____ inflation. This is a _____ relationship
   (due to) / (as a result of) — (result) / (definition)

4. The doe should be anaesthesized _____ the operation. This is a _____ relationship.
(prior to) (larger than)
(sequence) (compare/contrast)

5. The apple is _____ the orange. This is a _____ relationship.
(redder than) (depends on)
(compare/contrast) (example)

6. Extreme hunger _____ pain. This is a _____ relationship.
(causes) (depends on)
(result) (example)

Answers To Exercises on Pages 74 and 75.

1. Follows — This is a sequence link because although the seasons follow each other, they don't result from the previous season. They result from a change in the earth's orientation to the sun.

2. Costs more than — This is either a characteristic or a compare/contrast relationship. It can be considered a characteristic if you think of "cost" as "price" i.e., the Model T cost X, but it is more properly a compare/contrast because it cost more than the horse (horse + X).

3. Due to or as a result of — Either answer is correct, but both are results. Because the cost of living increase came from inflation, it is not a definition of inflation.

4. Prior to — Prior to makes more sense than larger than. The prior to relationship is a sequence because it tells what should be done first and what should happen next (the operation).

5. Redder or Higher Than — Either could be right. It would depend upon your point of departure. Both are comparing or contrasting two things. Neither tells that one is sequential to the other.

6. Causes — The result relationship is given. It is a result because _____. It is not an example of either hunger or pain.